GEP-167

IMPULSE TESTING EQUIPMENT

GENERAL ELECTRIC

GEP - 167

IMPULSE TESTING EQUIPMENT

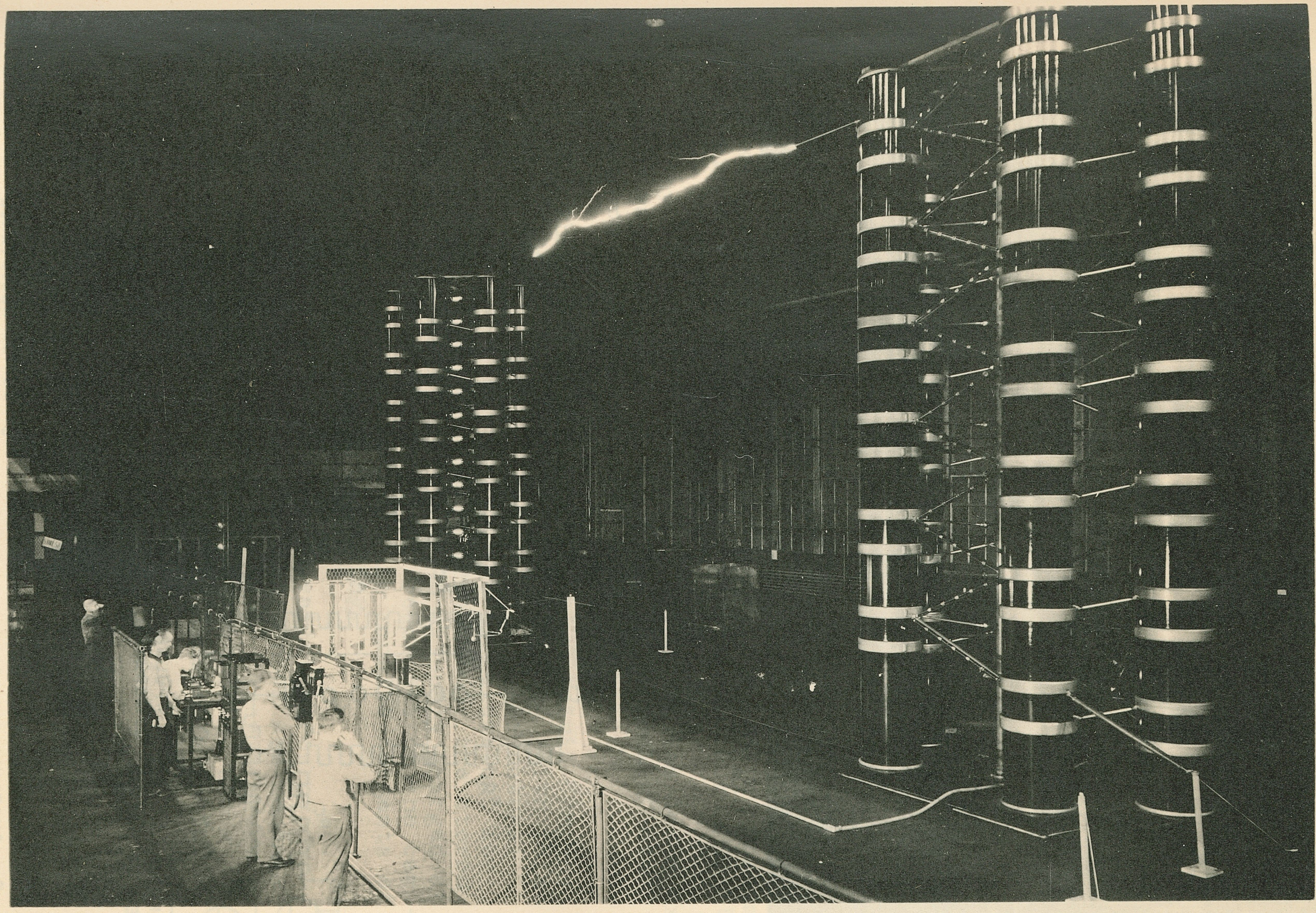
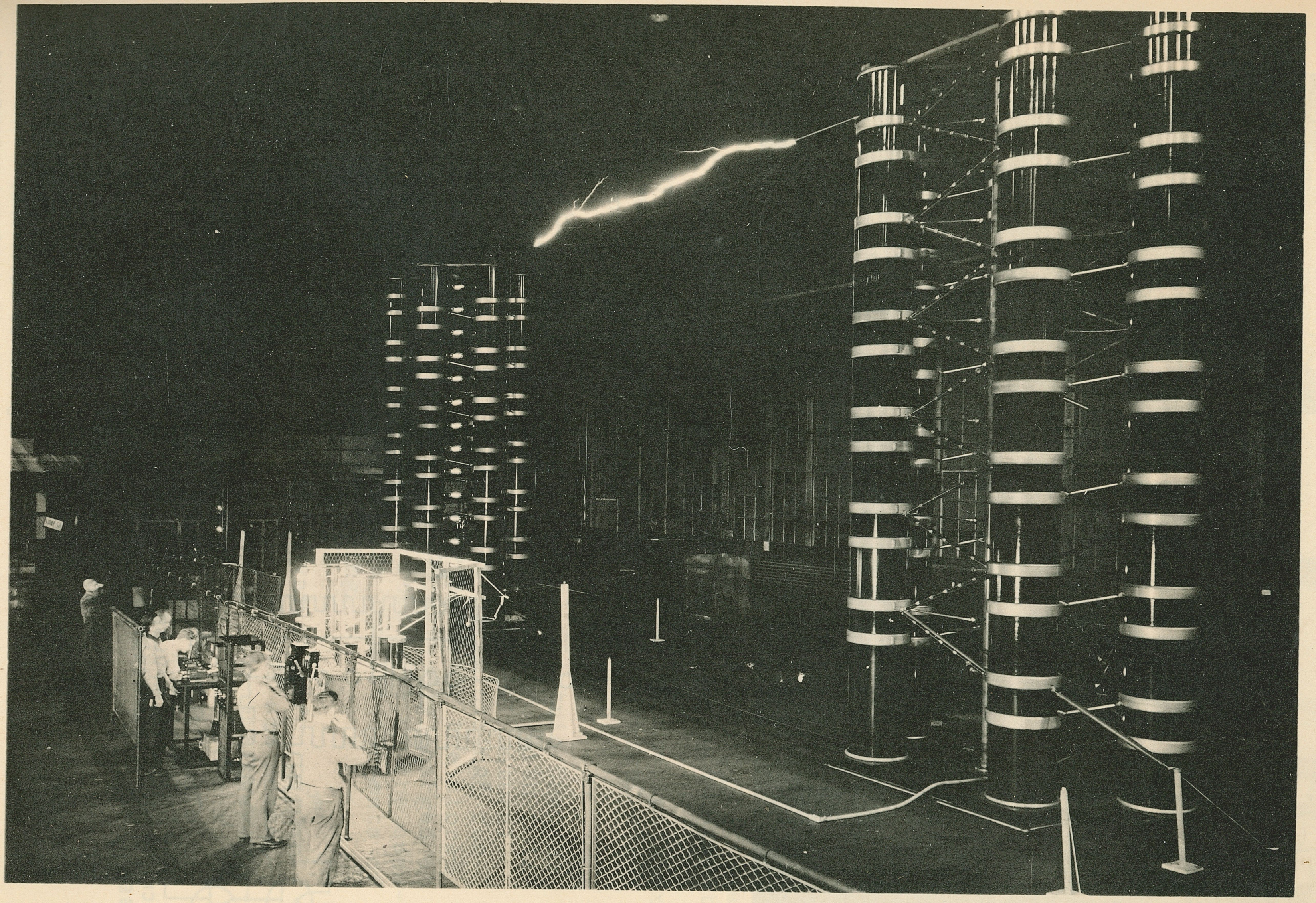


FIG.1 TEST ASSEMBLY OF G-E 10,000 KV IMPULSE GENERATOR FOR NEW YORK WORLD'S FAIR.



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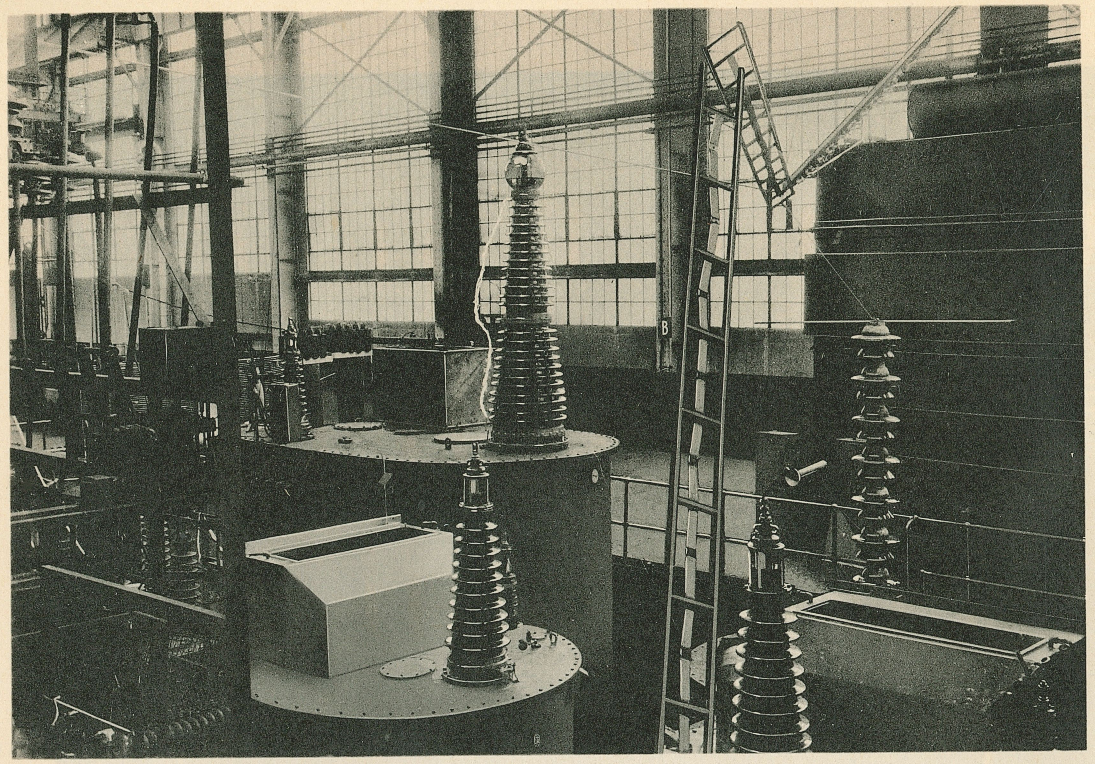
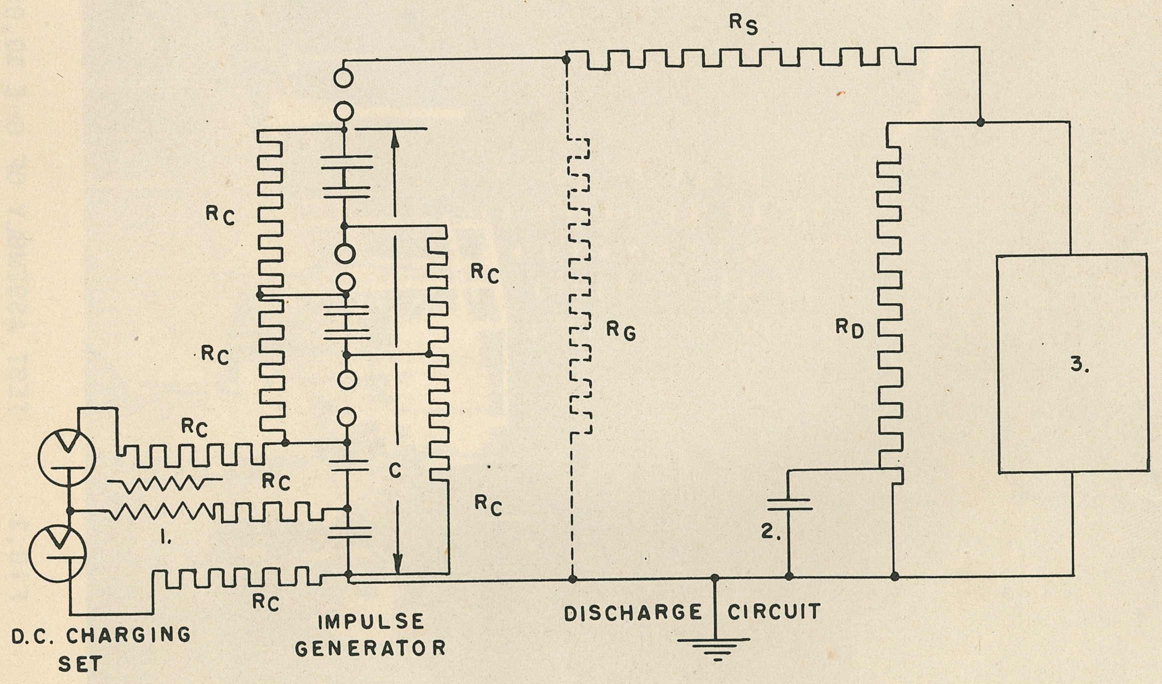


FIG.2 LARGE TRANSFORMER RATED 287,500 VOLTS BEING TESTED AT BUSHING FLASHOVER (1,430,000 VOLTS) UNDER STANDARD A.I.E.E. IMPULSE TEST.



SIMPLIFIED IMPULSE GENERATOR CIRCUIT

1.	HIGH VOLTAGE TRANSFORMER	R_D	DIVIDER RESISTANCE
2.	OSCILLOGRAPH PLATES	R_G	SHUNT RESISTANCE
3.	TEST PIECE	R_S	SERIES RESISTANCE
R_C	CHARGING RESISTORS	C	IMPULSE GENERATOR CAPACITANCE

FIG.3 SIMPLIFIED CIRCUIT

IMPULSE TESTING EQUIPMENT

Because lightning surges have been responsible for the majority of insulation failures and interruptions of service on electric systems, it is generally considered essential to design apparatus and lines to withstand impulse or surge voltage as well as normal frequency disturbances.

Impulse testing permits manufacturers of electric equipment to obtain complete test data on new designs, to make studies of impulse strength of apparatus insulation and to make thorough acceptance tests on equipment.

Many public utilities are finding impulse tests extremely valuable for investigating the effect of overvoltages on their circuits.

For these purposes, the General Electric Company offers complete impulse testing equipment. With this equipment the violent disruptive effects of natural lightning can be safely reproduced by releasing, for a controlled period of a few microseconds, the stored energy in a series of capacitors previously charged at high voltage. The extremely low reactance of the capacitors makes it possible to obtain impulse currents of the same order as natural lightning.

While various circuits are available for producing high impulse voltages, the best known and most commonly used is the so-called "Marx" circuit wherein the capacitor banks are charged in multiple from a moderately high-voltage d-c supply, and at a predetermined time, are discharged in series. The impulse generator circuit in simplest form is shown in Fig. 3.

General Electric impulse generators provide an unlimited number of wave shapes, including those recommended by the A. I. E. E. The three wave shapes that have been commonly used are:

1 x 5 microseconds
1 x 10 microseconds
1 1/2 x 40 microseconds

The first number refers to the wave front and represents the time in microseconds for the wave to rise from zero to crest voltage. The second number represents the time in microseconds, measured from zero voltage, for the wave to decay to half of its crest value.

In accordance with the conditions of the test and the nature of the test sample, breakdown may cause the voltage wave to be chopped on the tail, crest, or front. By proper arrangement of the circuit constants and the impulse voltage, wave front tests of, for example, 1000, 1500, or 2000 kv per microsecond, may be readily performed.

Impulse generator equipments are usually arranged for indoor permanent installation. Sets up to 1500 kv may, however, be made portable either by means of a small self-contained truck or by mounting on an automobile truck or trailer. Where equipments may be used out-of-doors, special provision must be made for housing certain parts and to protect the set as a whole from severe weather conditions.

FEATURES OF G-E IMPULSE GENERATORS

1. The control equipment is furnished with contacts for positive interlocking with safety devices (gates, signal lamps, etc) provided by the purchaser. A grounding switch automatically grounds both sides of the impulse generator when charging power is turned off.

2. All parts of the equipment are readily accessible, thus decreasing the time and work required for changeovers, such as paralleling sections of the generator.

3. Complete control is obtained and all parts are visible from one operating position.

4. With the automatic timing unit, a series of discharges from the impulse generator at uniform intervals may be obtained without attention from the operator. This also makes it possible for the operator to observe the apparatus under test from any position he desires.

5. The impulse generator may be synchronized with the excitation voltage of the apparatus under test, permitting discharge at a predetermined part of the 60-cycle wave.

6. The sphere gaps between capacitor groups may be adjusted simultaneously by remote control, thus varying the impulse voltage without delay.

7. An assortment of non-inductive resistance units provides for any desired wave shape.

8. The assembly is compact, requiring relatively small floor space, and saving on building investment. The equipment can readily be added to whenever desired to increase the voltage and energy ratings.

THE IMPULSE GENERATOR

Fig. 4 shows a typical impulse generator circuit; also the sequence of operation of the following principal parts:

A. Main capacitor assembly, including charging resistors and sphere gaps for series discharge.

B. High-voltage d-c supply for charging the capacitors.

C. Complete control equipment for operating the impulse generator.

D. A cathode ray oscillograph for observing and accurately recording the impulse voltage.

E. Wave-shape control resistors, including a voltage divider for obtaining the impulse voltage by ratio on the deflecting plates of a cathode-ray oscillograph.

F. Tripping unit, for initiating the discharge and co-ordinating the operation of the generator and oscillograph.

MAIN CAPACITOR ASSEMBLY

The main capacitor assembly consists of a number of individual Pyranol capacitor units, their arrangement depending upon the final selection of the generator rating and the d-c charging voltage. The discharge energy available is a function of the series capacitance and the total voltage selected. Typical characteristics are shown in Table 1 (Page 10).

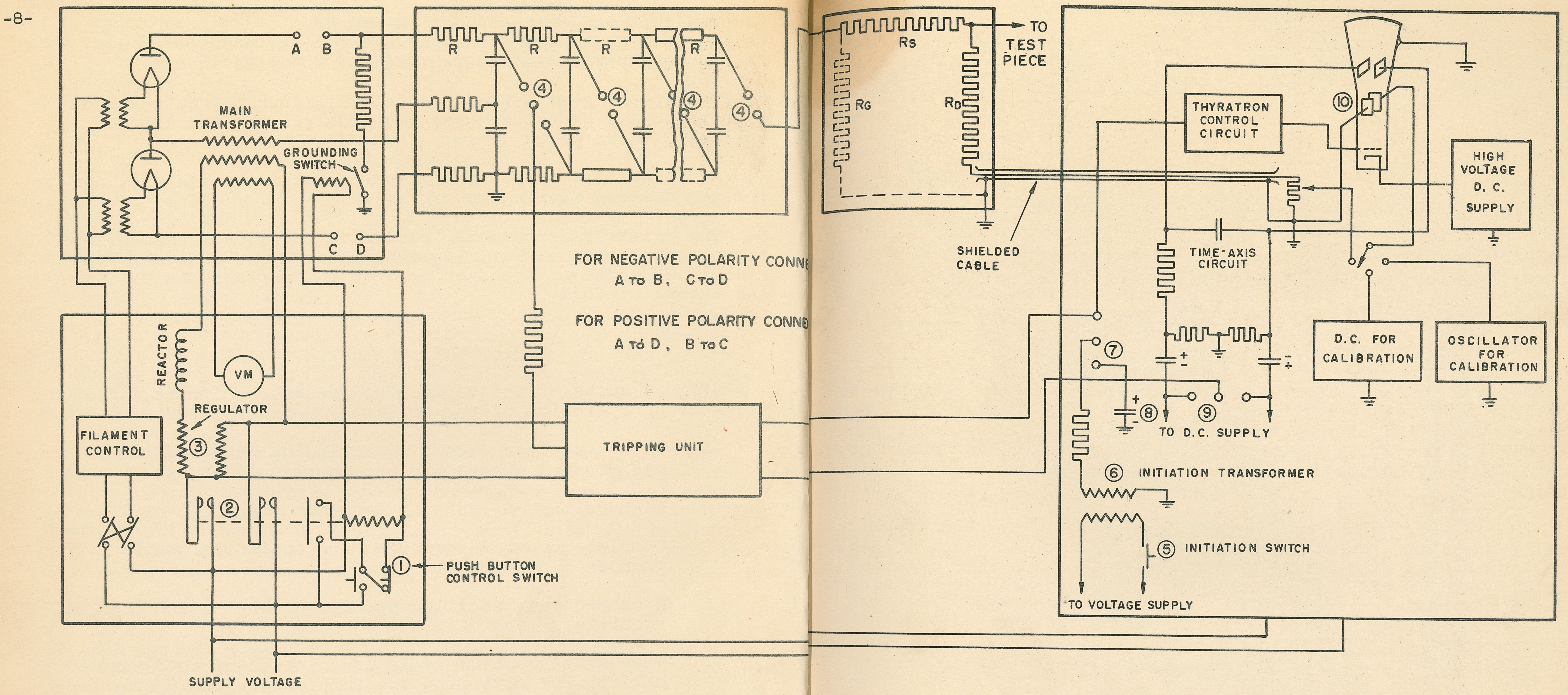


FIG.4 SEQUENCE OF OPERATION OF THE TESTING EQUIPMENT

1. OPERATING PUSH BUTTON CONTROL SWITCH ① CAUSES CONTACTOR ② TO CLOSE, THEREBY ENERGIZING THE D-C CHARGING SET OF THE IMPULSE GENERATOR.
2. BY MEANS OF REGULATOR ③, THE CHARGING VOLTAGE IS BROUGHT UP TO THE DESIRED VALUE. PREVIOUSLY THE SPHERE GAPS ④ MUST HAVE BEEN ADJUSTED TO WITHSTAND THE CHARGING VOLTAGE.
3. TO INITIATE DISCHARGE OF IMPULSE GENERATOR, OPERATOR CLOSES INITIATING SWITCH ⑤ ON THE OSCILLOGRAPH.
4. INITIATING TRANSFORMER ⑥, THEN BREAKS DOWN 3-ELECTRODE GAP ⑦ WHICH IMMEDIATELY ASSUMES THE POTENTIAL OF THE CAPACITOR ⑧.
5. THE VOLTAGE OF THIS IMPULSE IS TRANSMITTED TO THE TRIPPING UNIT WHICH APPLIES A HIGH VOLTAGE IMPULSE TO 3-ELECTRODE GAP ④ ON THE IMPULSE GENERATOR. THE INITIAL IMPULSE ALSO OPERATES A THYRATRON CONTROL CIRCUIT WHICH INITIATES THE CATHODE RAY IN THE TUBE.

THE 3-ELECTRODE GAP ④, THUS BREAKS DOWN AND THE RESULTING HIGH POTENTIALS ACROSS THE REMAINDER OF THE SPHERE GAPS CAUSES ALL TO BREAK DOWN, THEREBY APPLYING THE FULL SERIES IMPULSE VOLTAGE TO THE TEST PIECE.

COINCIDENTAL WITH SEQUENCE 5, AN IMPULSE FROM THE TRIPPING UNIT ALSO BREAKS DOWN 3-ELECTRODE GAP ⑨ IN THE OSCILLOGRAPH, AND INITIATES THE TIME-AXIS CIRCUIT.

AS THE CATHODE RAY SWEEPS ACROSS THE SCREEN, THE IMPULSE WAVE POTENTIAL IS APPLIED ACROSS THE DEFLECTING PLATES ⑩ THROUGH THE VOLTAGE DIVIDER RD. THUS AN OSCILLOGRAM IS OBTAINED OF THE DISCHARGE.

TABLE 1

KV RATING OPEN CIRCUIT	CHARGING KV, D-C	NO. OF CAPACITOR GROUPS	**EQUIV.DISCHARGE ENERGY KW--SECS			*FLOOR SPACE FT.	MIN. HT. FT.	MIN. CLEARANCE FT
500	100	5	1.25	3.12	6.25	3 x 4	8	4
800	100	8	2.00	5.00	10.00	3 x 4	11	6
1000	100	10	5.00	12.50	16.50	6 x 6	12	8
1500	100	15	7.50	18.75	24.75	8 x 8	17	12
2000	100/200	10/20	10.00	25.00	33.00	10 x 10	22	16
3000	200	15	15.00	37.50	49.50	10 x 10	30	24

*These dimensions include only the main capacitor assembly and make no allowance for testing space or the control equipment.

**For each kv rating, generators of three different energy ratings are available.

For the smaller, lower-voltage equipments (below 1000 kv) the capacitor units generally have conventional rectangular metal cases Fig. 2. These are usually assembled on insulating supports, with the gaps and resistors assembled at or adjacent to the capacitor terminals. Fig. 6 shows a portable equipment being used for field studies.

The larger, higher-voltage equipments (1000 kv and above) are usually built with capacitors that have cylindrical cases of Herkolite insulation, with base and cover plates of the same material. Fig. 7. Tubular rings at top and bottom provide a means of securing the cover plates and terminal connections and also serve as stress-distributing shields, providing high flashover strength. The capacitors are stacked one above another with Herkolite insulating cylinders between them, forming a self-supporting column.

Fig. 8 shows a typical assembly of a 2200 kv generator, consisting of four columns of capacitors mounted on a steel base.

Fig. 9 shows a similar equipment with generator rated 3000 kv.

The structure is further strengthened by a rigid insulating framework across the top, as well as by the metal connecting rods and Herkolite resistor-supports between columns.

Charging resistors are so connected between adjacent capacitors (or groups of capacitors) as to allow the capacitors to be charged in parallel and also to allow them to discharge in series through the sphere gaps. These sphere gaps are conveniently located in the center of the generator, readily accessible and easily adjustable by means of either a remote-controlled motor-drive

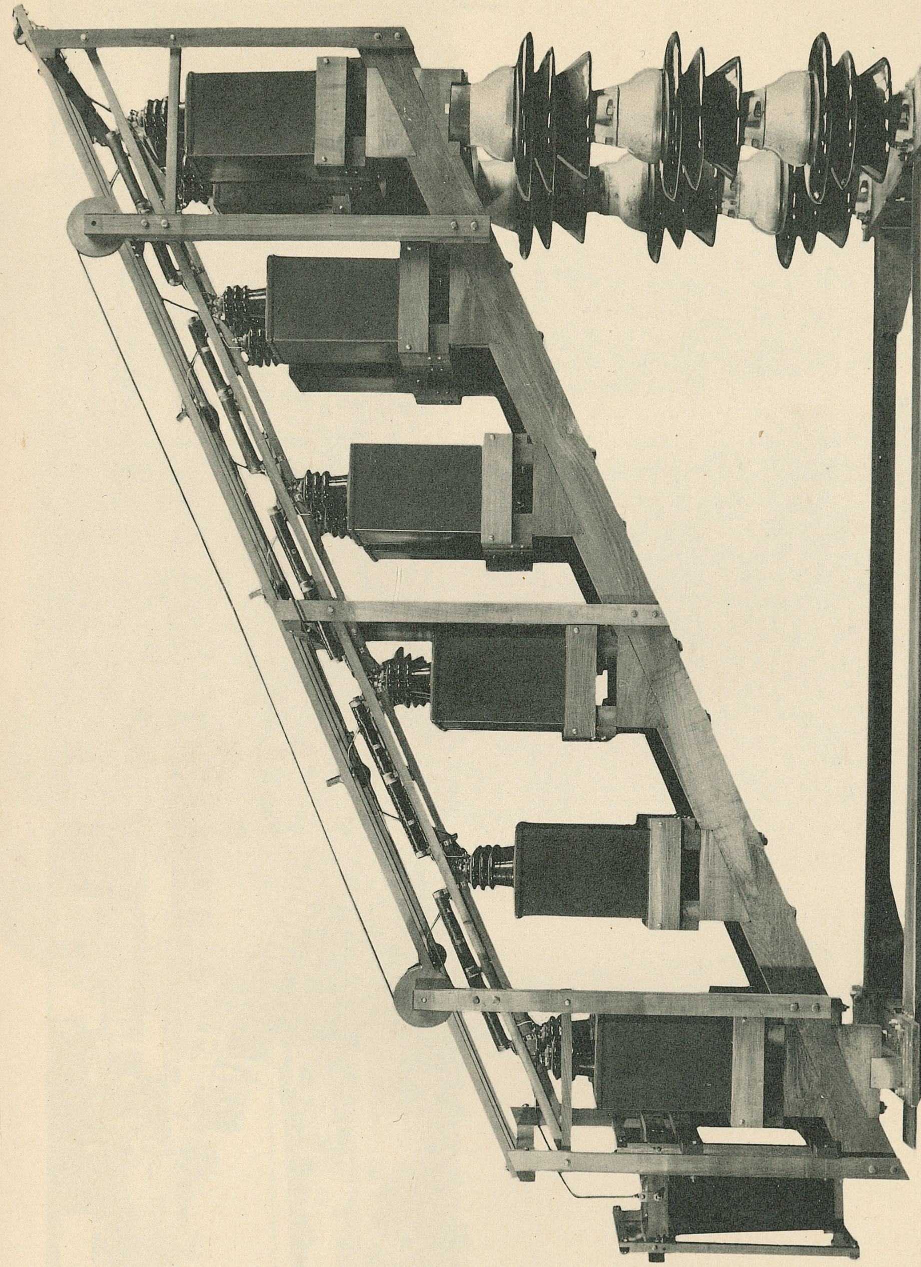


FIG.5 G-E 600-KV, 0.042-MICROFARAD PORTABLE IMPULSE GENERATOR

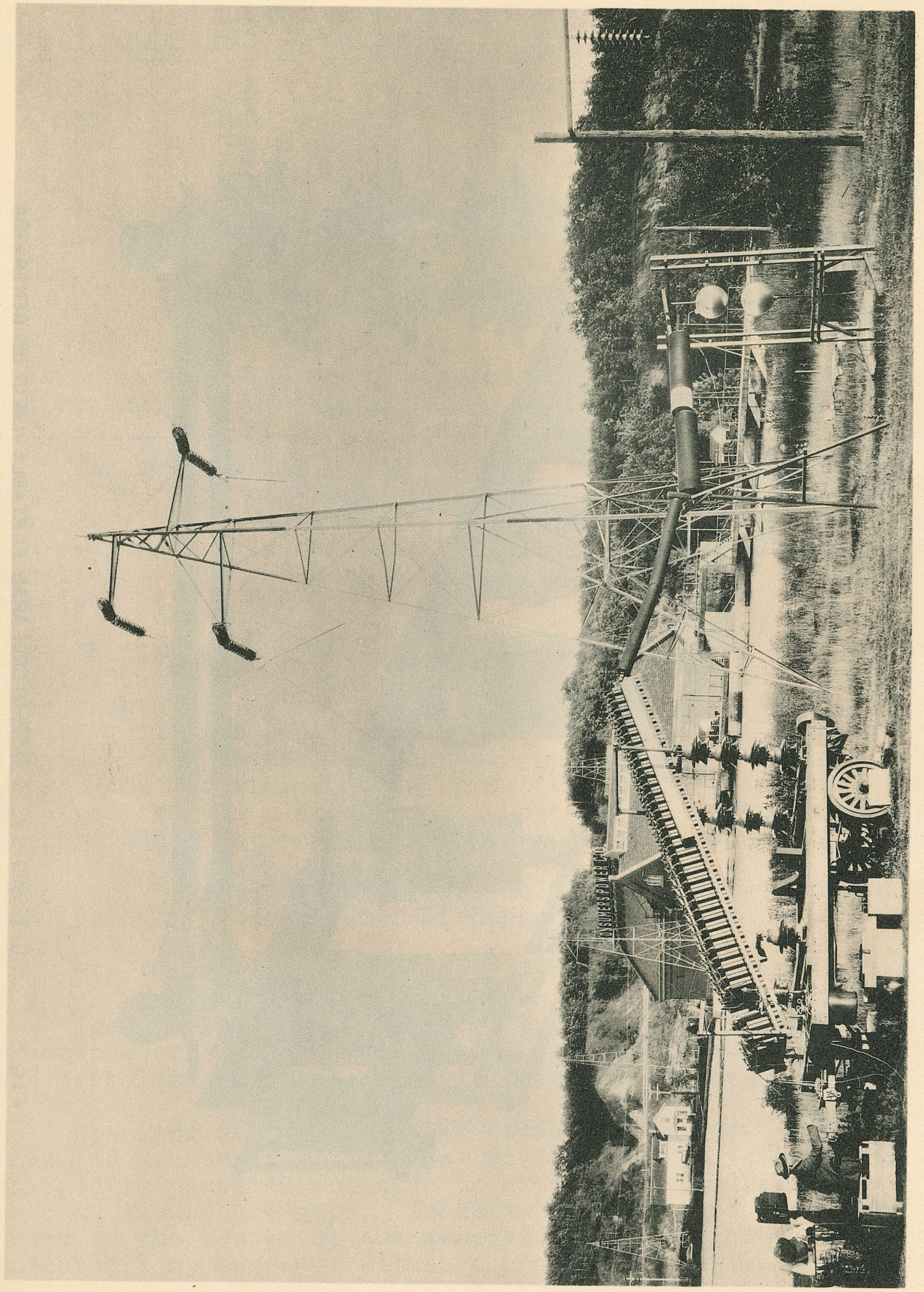


FIG.6 PORTABLE IMPULSE GENERATOR IN USE ON LINES OF CONSUMERS POWER COMPANY AT CROTON DAM, MICHIGAN.

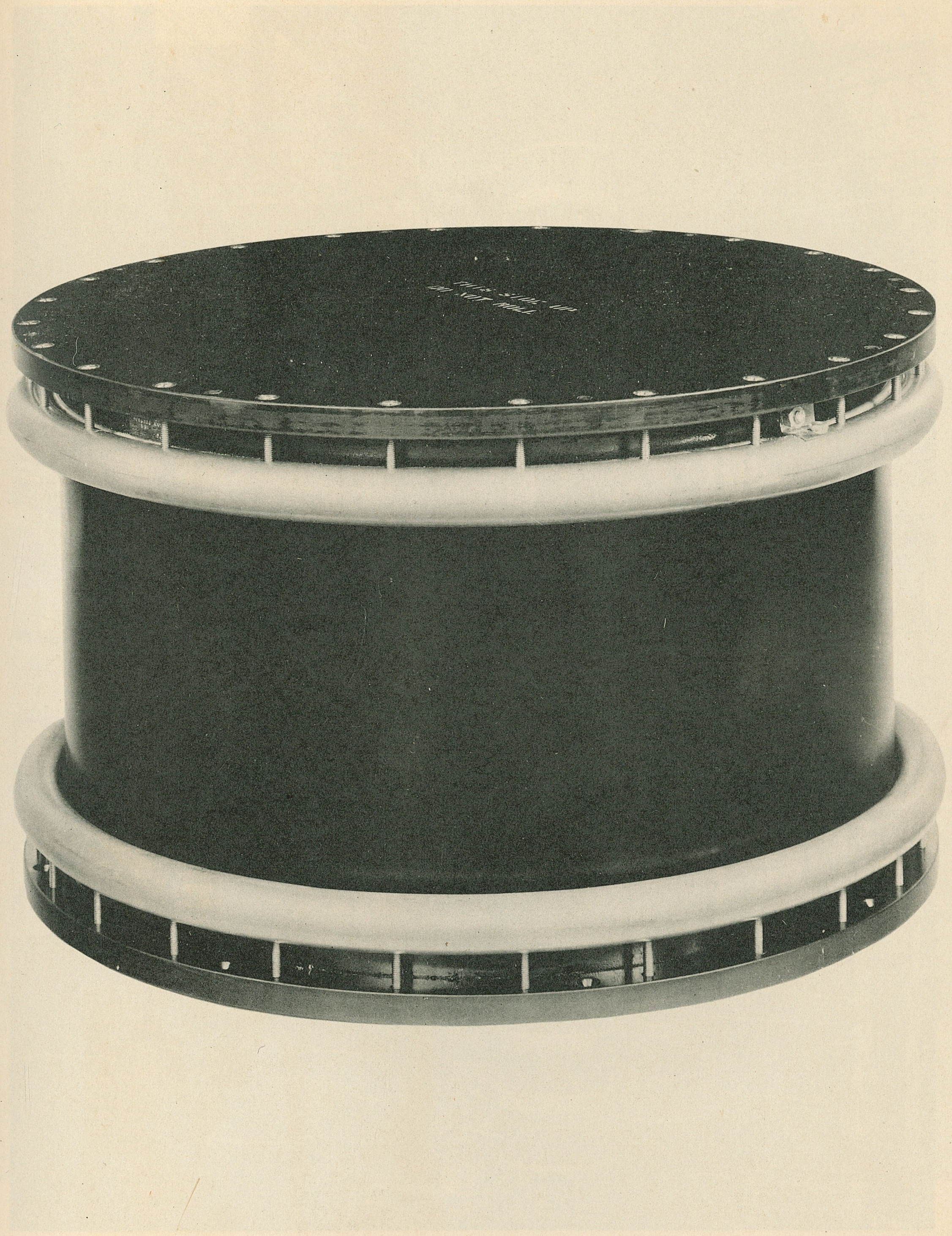


FIG.7 G-E PYRANOL CAPACITOR RATED 0.33 MICROFARADS, 100 KV D-C, FOR IMPULSE GENERATOR APPLICATION.

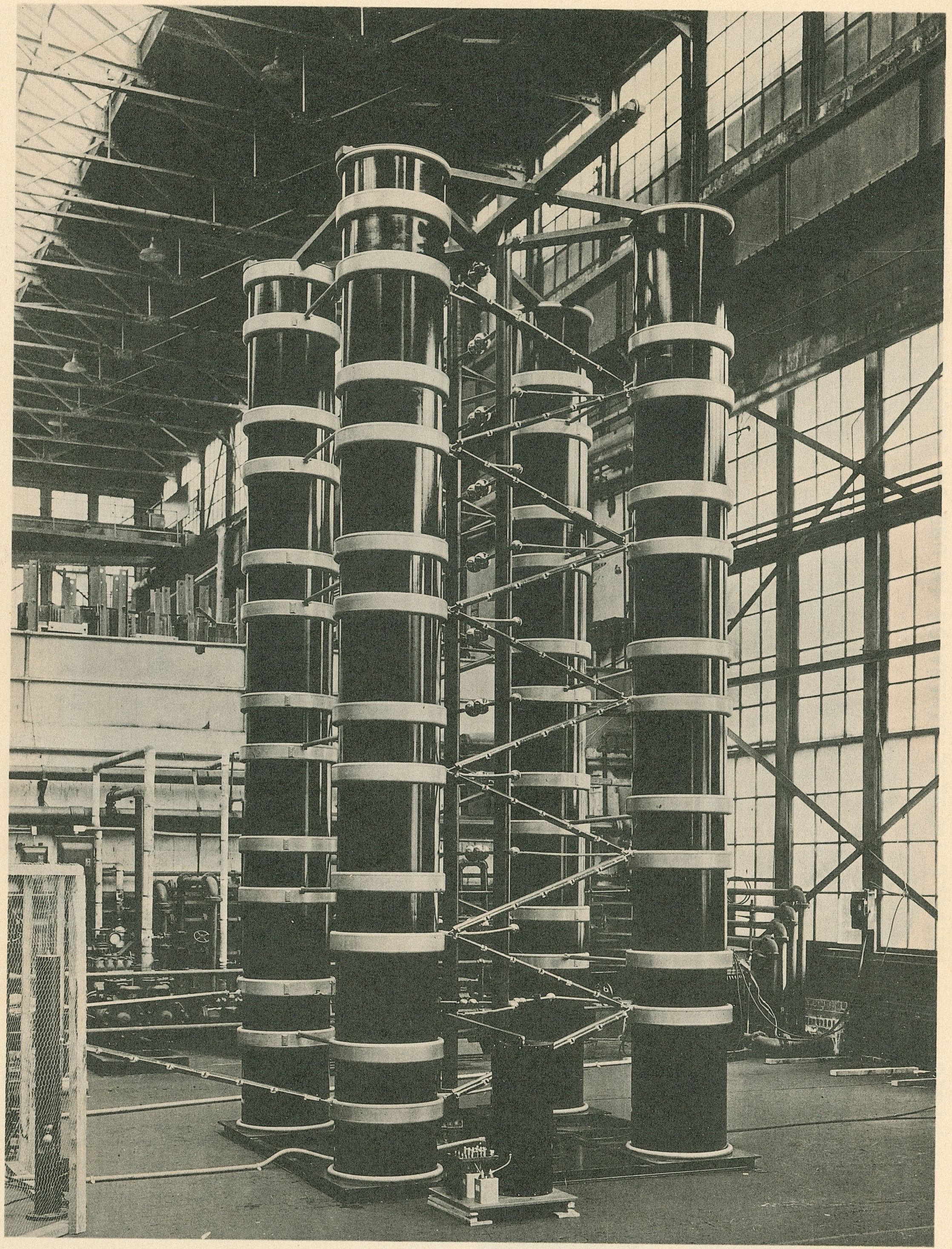


FIG.8 G-E 2200-KV IMPULSE GENERATOR, SHOWING INITIATING UNIT IN FOREGROUND.

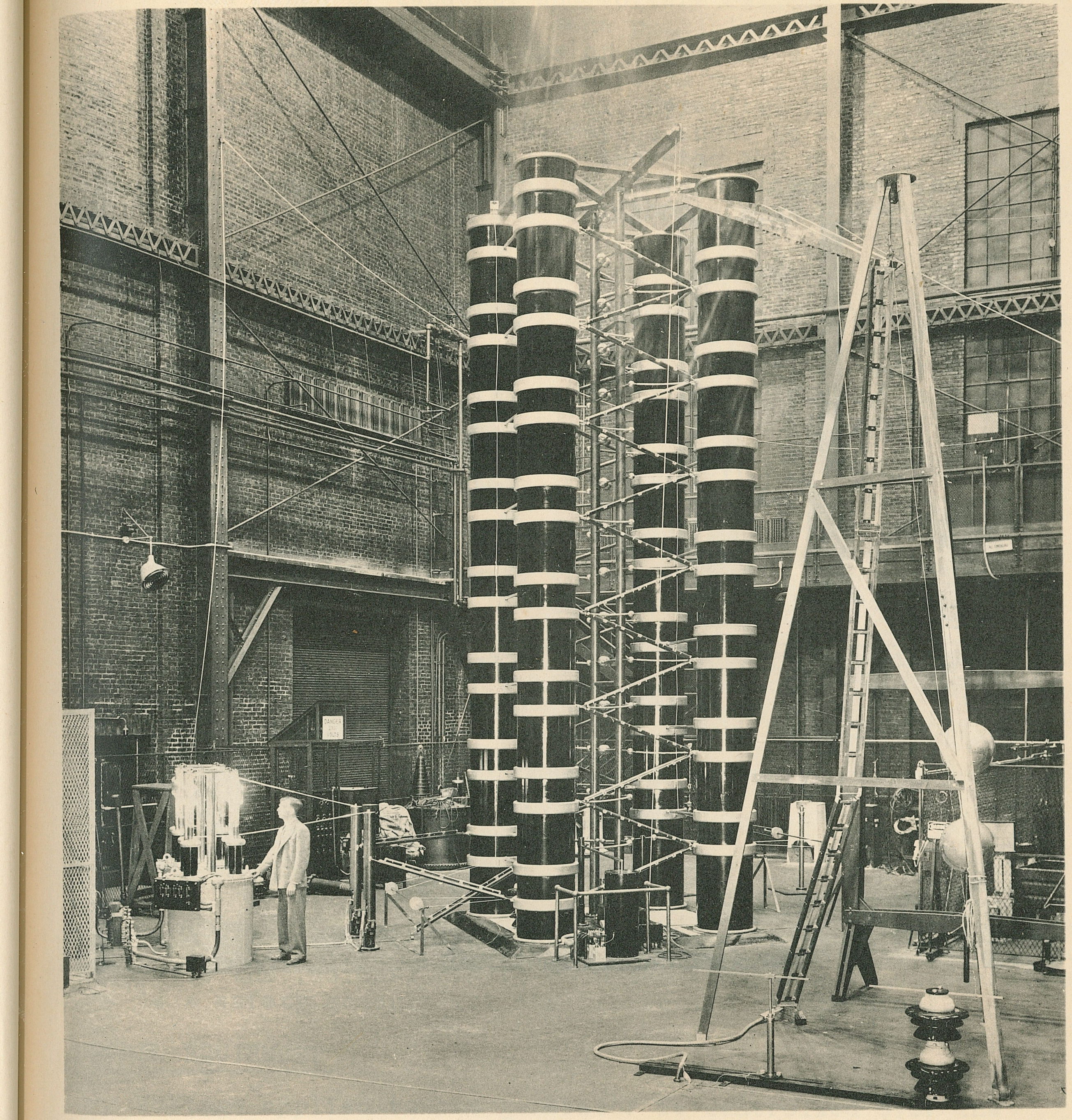


FIG.9 G-E IMPULSE GENERATOR, RATED 3000 KV, 49.5 KW-SECONDS. LEFT-CHARGING EQUIPMENT. CENTER-MAIN CAPACITOR ASSEMBLY. RIGHT-WAVE-SHAPE CONTROL RESISTORS AND GAPS.

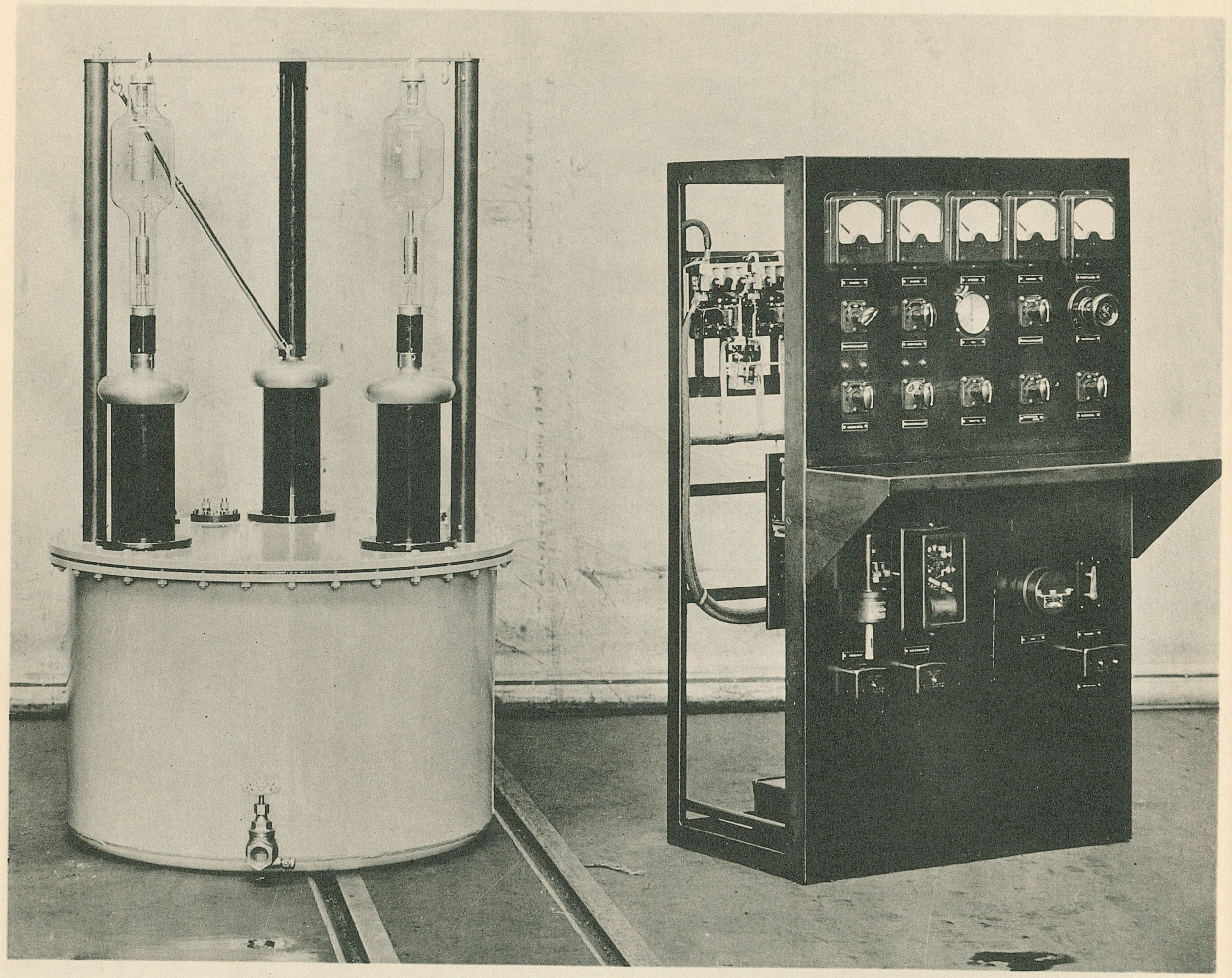


FIG.10 G-E 100~~0~~-KV, HALF-WAVE CHARGING UNIT FOR IMPULSE GENERATOR, WITH CONTROL PANEL.

or a single manual control at the base of the generator. Gap spacings may be indicated by a Selsyn indicator located on the control panel.

A wide range of capacity and voltage ratings in complete impulse generator equipment is made possible through the availability of individual capacitors of three different capacitances--namely: 0.10 mu f, 0.25 mu f, and 0.33 mu f, each of which is designed for service at 100 kv d-c. Capacitor units, together with the necessary auxiliaries, may be added to existing equipment at any time it is desired to increase the rating. Capacitor groups are readily arranged in parallel for higher-current testing and for further control of the discharge wave characteristics.

HIGH-VOLTAGE D-C SUPPLY

The kenotron rectifier for supplying the d-c charging voltage is generally supplied in one of two ratings -- i.e., 100 kv or 200 kv and is designed so that both polarities are available. Since the load is relatively small and intermittent, half-wave rectification is generally supplied, although full-wave rectification can be furnished if desired.

It consists of a combined main and filament transformer in a common tank with the kenotron tubes mounted on the high-voltage terminals, and with a sturdy insulated supporting structure for the anode connections and series resistors. A 100-kv half-wave unit is shown at the left in Fig. 10.

The main transformer is equipped with a potential coil so placed with respect to the high-voltage winding as to determine accurately, by ratio, the potential of that winding. A voltmeter used with the potential coil, permits direct reading of the actual voltage applied to the impulse generator. This can be a crest voltmeter, if so specified.

All winding terminals are conveniently located on the main transformer cover, for connection to the control panel.

An automatic, solenoid-operated discharge switch, interlocked with the main supply contactor, short circuits the capacitors and dissipates the residual charge when the equipment is de-energized. This is a safety measure for the protection of operators.

CONTROL EQUIPMENT

Voltage applied to the generator is controlled over the complete range from zero to maximum by an induction voltage regulator. This regulator may be hand-operated direct from a handwheel located at the control panel, or may be motor-operated with a remote control switch on the panel.

The main control panel may be furnished in the benchboard type or as a single vertical unit. This panel (at right in Fig. 10) includes:

A main supply contactor with push-button control
Hand-reset overload relay, with current transformer
Filament rheostat and voltmeter
D-C ammeter to indicate charging current
Voltmeter to indicate charging voltage
Auxiliary control switches and indicating lamps

A reactor limits the charging current supplied by the rectifier and is so designed as to permit a continuous series of operations of the generator.

Fig. 11 shows the control equipment on the panel of a complete portable d-c charging unit.

WAVE SHAPE CONTROL RESISTORS AND VOLTAGE DIVIDER

The desired shape of the impulse wave is obtained by means of non-inductive resistors assembled, on insulating supports, both in series and in parallel with the test piece. They are furnished in a wide range of values and are mechanically interchangeable, making it easy to obtain the desired value of resistance.

The voltage divider, Rd, shown diagrammatically in Fig. 3 and 4 constitutes one of the parallel resistance assemblies. It is connected directly to the test piece and grounded, through a shielded cable, to a tapped resistance in the oscillograph. The ohmic value of the tapped resistance is equal to the surge impedance of the cable, thus eliminating reflections. By selecting the proper tap a suitable oscillogram deflection is obtained. This resistance-type divider is the simplest and most practical for general impulse testing.

It is generally possible to obtain the desired wave shape and impulse voltage by adjusting the series resistance, Rs, and the divider resistance, Rd. However, for voltages near the maximum output of the set, the shunt resistor Rg is required to minimize the voltage drop across Rs to the test piece. It may be more convenient to leave the divider resistance fixed at a high value and control the wave shape by means of Rs and Rg only. Therefore, the shunt resistance assembly, Rg, is included as standard equipment.

TRIPPING UNIT

A tripping unit is provided to insure dependable initiation of the generator discharge and to co-ordinate this operation with that of the oscillograph.

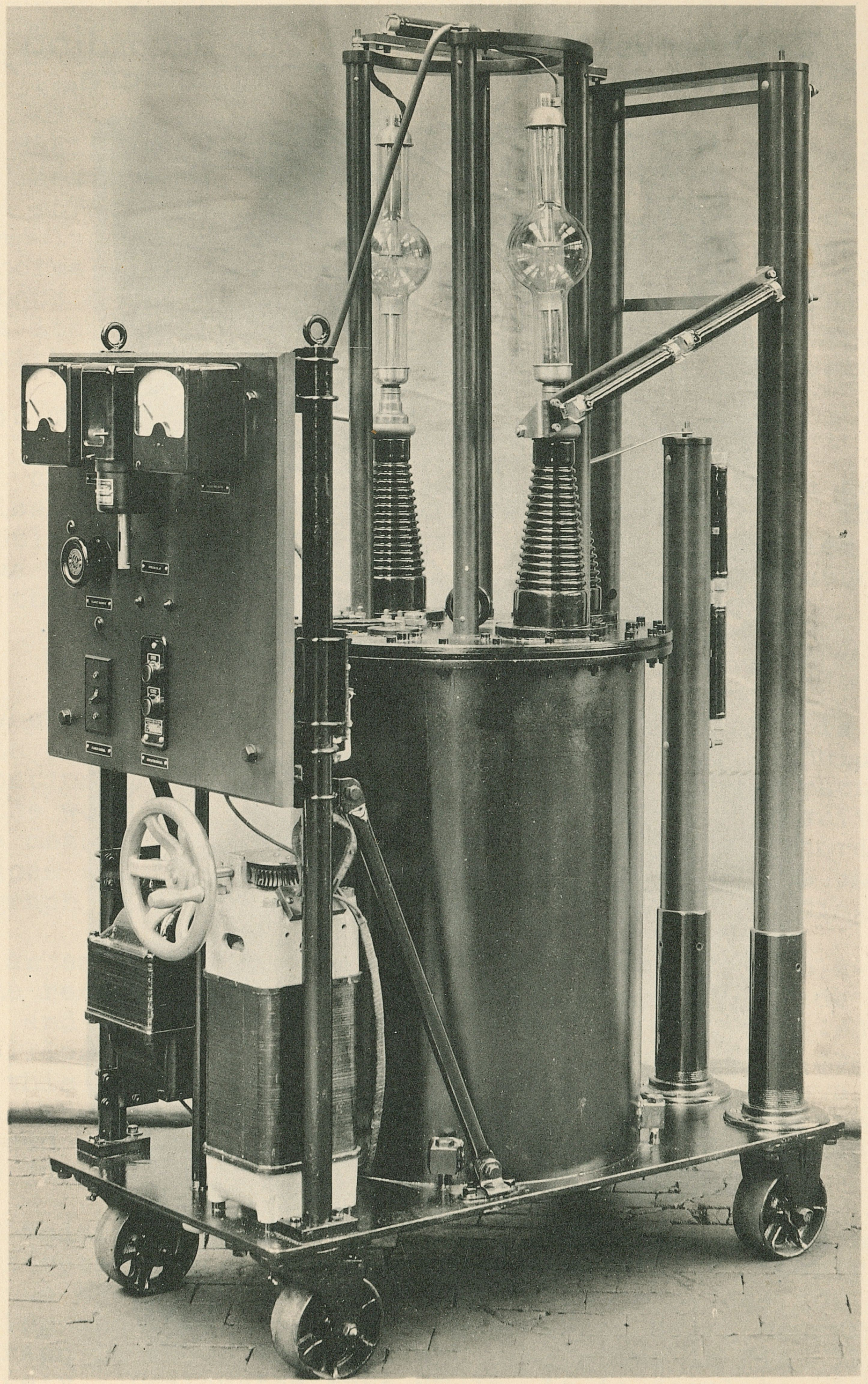


FIG.11 G-E PORTABLE D-C CHARGING UNIT AND CONTROL,
FOR 1000-KV IMPULSE GENERATOR.

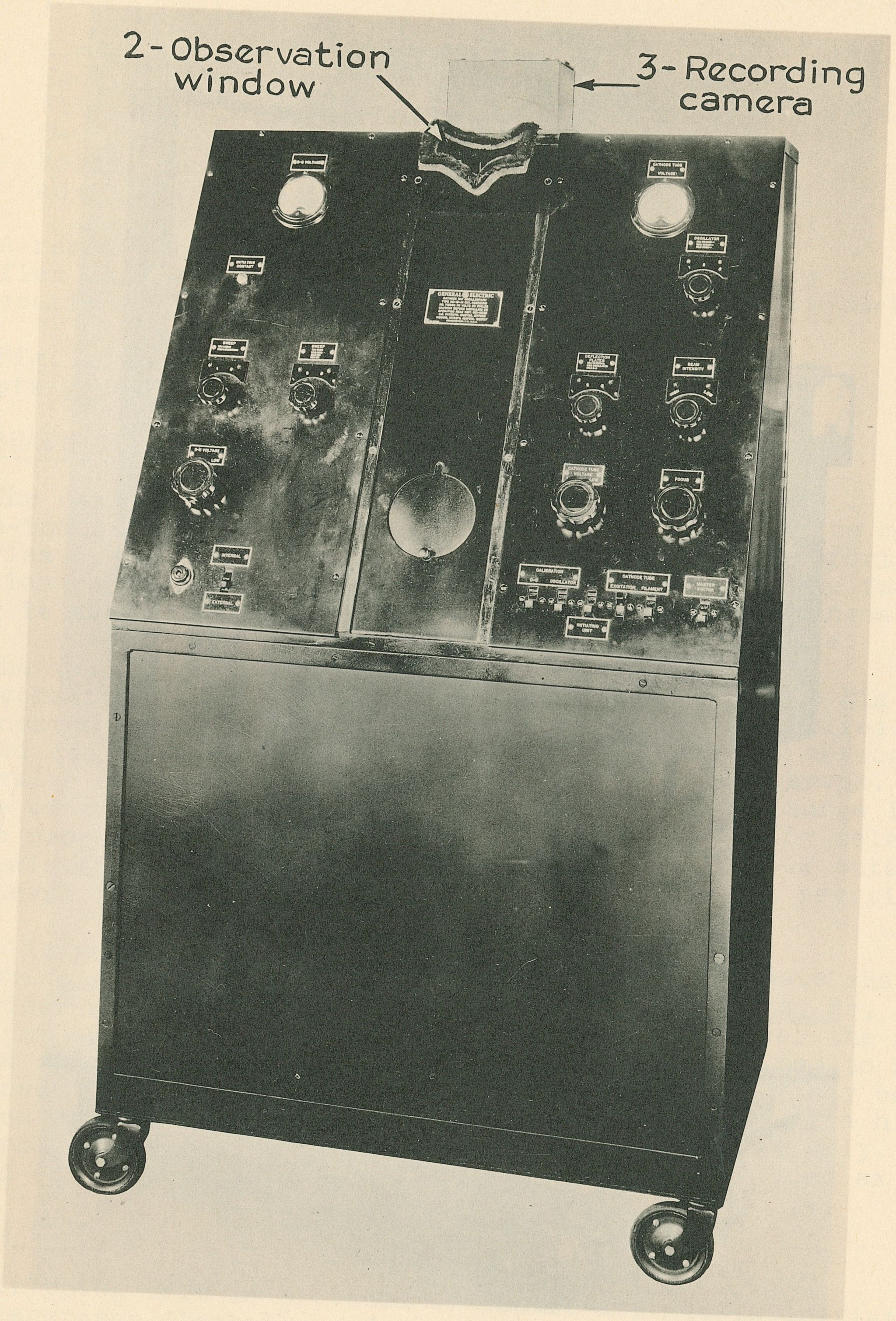


FIG.12 G-E PORTABLE CATHODE-RAY OSCILLOGRAPH, TYPE HC-15. FRONT VIEWING WINDOW CLOSED.

The initiation impulse may be applied by a push button located either on the control panel or oscillograph panel, or it may be initiated by the automatic timing unit described below, if this is incorporated in the control. The initiating impulse causes the tripping unit to impress a high-voltage impulse on the initiating sphere gap of the generator, giving dependable and consistent firing.

If desired, the initiation circuit may be so arranged that the impulses applied to the apparatus under test are synchronized with the normal-frequency excitation voltage of that apparatus. Thus, impulses may be applied near the crest, of either polarity, of the normal-frequency excitation voltage. This requires a synchronous high-voltage switch which must be specified as a separate item. This switch is driven by a small synchronous motor, with provision for adjustment to obtain the desired timing.

Automatic Timing Unit

The automatic timing unit may be set to trip the generator automatically after a predetermined charging period. Thus repetitive impulse voltages of constant values may be applied to the apparatus under test in shorter intervals and more accurately, than if the set were tripped by hand.

CATHODE-RAY OSCILLOGRAPH

The unit of time in the work of impulse testing is one millionth of a second. Within ten microseconds is included a great portion, and within one hundred microseconds practically all of the work in this field. The only instrument suitable for both the measurement of voltage amplitude and the recording of wave shapes within this very short-time range, is the cathode-ray oscillograph which has a practically unlimited recording speed.

In an early form of this oscillograph, of the cold-cathode type, the recording photographic film is located inside a vacuum chamber, and a complete evacuation equipment is supplied with each oscillograph. At frequent intervals during the progress of a test, this chamber must be opened for film removal, a new film inserted, and re-evacuation and pressure adjustment repeated. The exposed films are later developed and not until then can it be known just what the records contain.

The modern G-E cathode-ray oscillograph is of the hot-cathode type. It retains the high recording speeds of the early form, but requires no evacuation equipment. It also provides for simultaneous viewing and recording of the wave shape being measured. This oscillograph is shown in front and rear views in Fig. 12 and 13 respectively. Designated type HC-15, it is complete with oscillograph tube, recording camera, calibrating and co-ordinating auxiliaries and control panel.

Type HC-15 oscillographs have now been in use since 1935, on a wide range of work including both recurring and non-recurring phenomena. The same oscillograph with proper voltage dividers has been used for surge voltages from two million down to two thousand volts. It is especially well adapted to commercial acceptance tests because of the feature of simultaneous visual and photographic recording. It has also been used for surge analysis of circuits and machinery with considerable saving in time and expense over the cold-cathode oscillograph.

THE TUBE

The deflecting element of the oscillograph is a beam of high-velocity electrons (cathode-ray) normally on the longitudinal axis of a highly evacuated, sealed glass tube (1 in Fig. 13). This ray is generated and sharply focused in a hot-cathode electron gun at the small (lower) end of the tube, passes upward through the field of two right-angled sets of deflecting plates, and on through the large (upper) end of the tube until it strikes the inner surface of a glass window, which is coated with a screen of fluorescent material. The high-velocity electrons striking this material cause a bright green trace which is easily viewed or photographed through the glass. The observation window (2 in Fig. 12) and the camera (3 in Fig. 12 and 13) are at the top of the panel board.

THE AUXILIARIES

The auxiliaries required are located on convenient shelf-trays around the tube, within a portable steel cabinet which is 3 feet wide, 2 feet deep, and 5 feet high.

The cathode-excitation-circuit unit (4 in Fig. 13), is a double-wave, a-c to d-c vacuum-tube rectifier circuit which provides an unvarying source of 15 kilovolts for the high-velocity electron beam. Across this high voltage is connected a non-inductive, tapped-resistor-type, voltage divider from which are taken the required intermediate voltages for cathode beam control. A control-grid-rheostat provides for variations of voltage from complete beam shut-off to full intensity. Focusing potential is independently adjusted through a separate rectifier circuit. For recording, where high beam-writing speed is not required, the cathode voltage is conveniently reduced by a control panel-rheostat. The voltage in use is indicated on a panel-board instrument.

The beam-initiating-circuit unit (5 in Fig. 13) in addition to providing means for automatically starting the electron beam, also limits its total time duration. In this manner possible damage to the fluorescent screen through over-exposure is prevented.

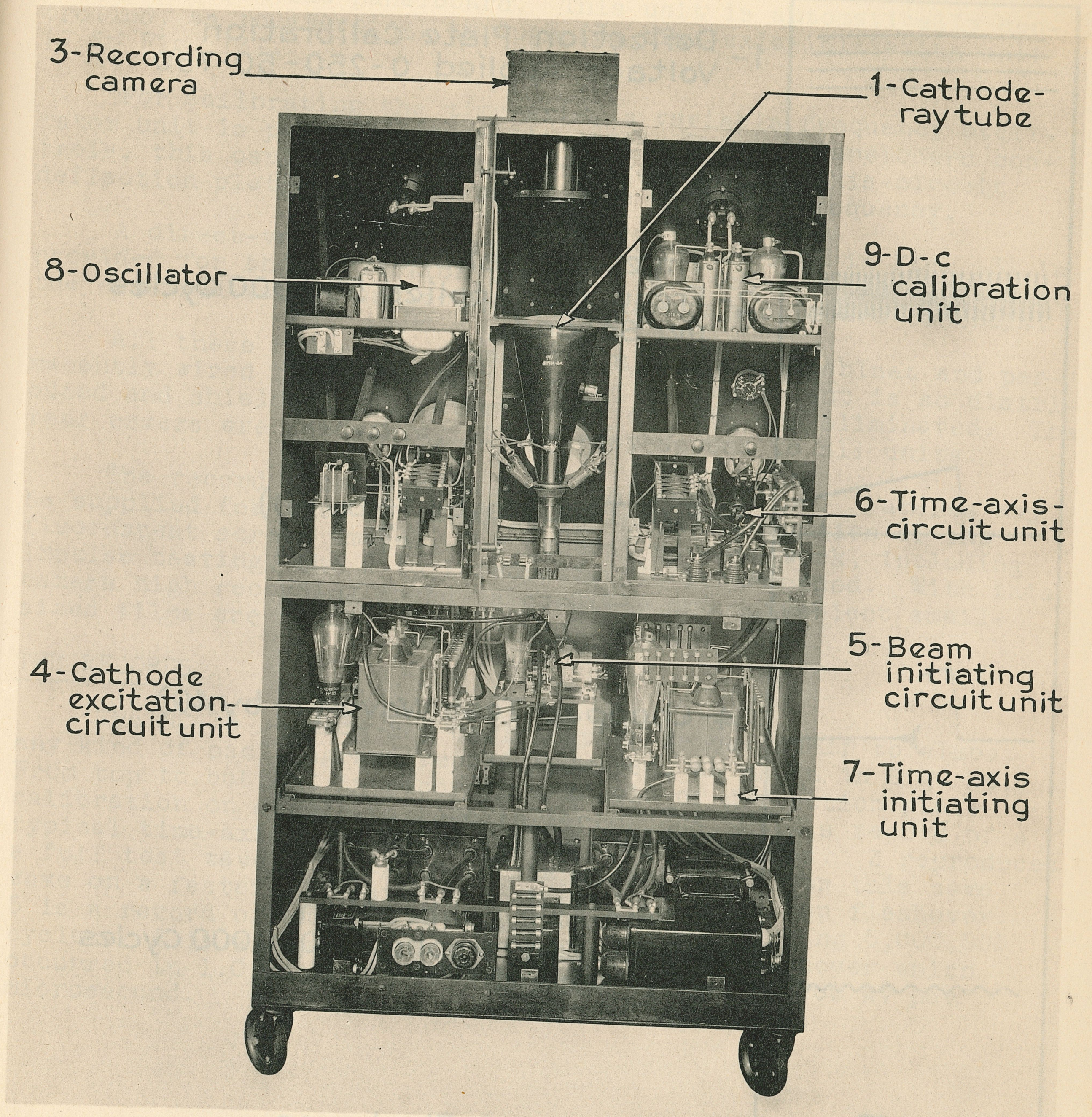


FIG.13 G-E PORTABLE CATHODE-RAY OSCILLOGRAPH, TYPE HC-15. REAR - WITH COVERS REMOVED TO SHOW INTERIOR.

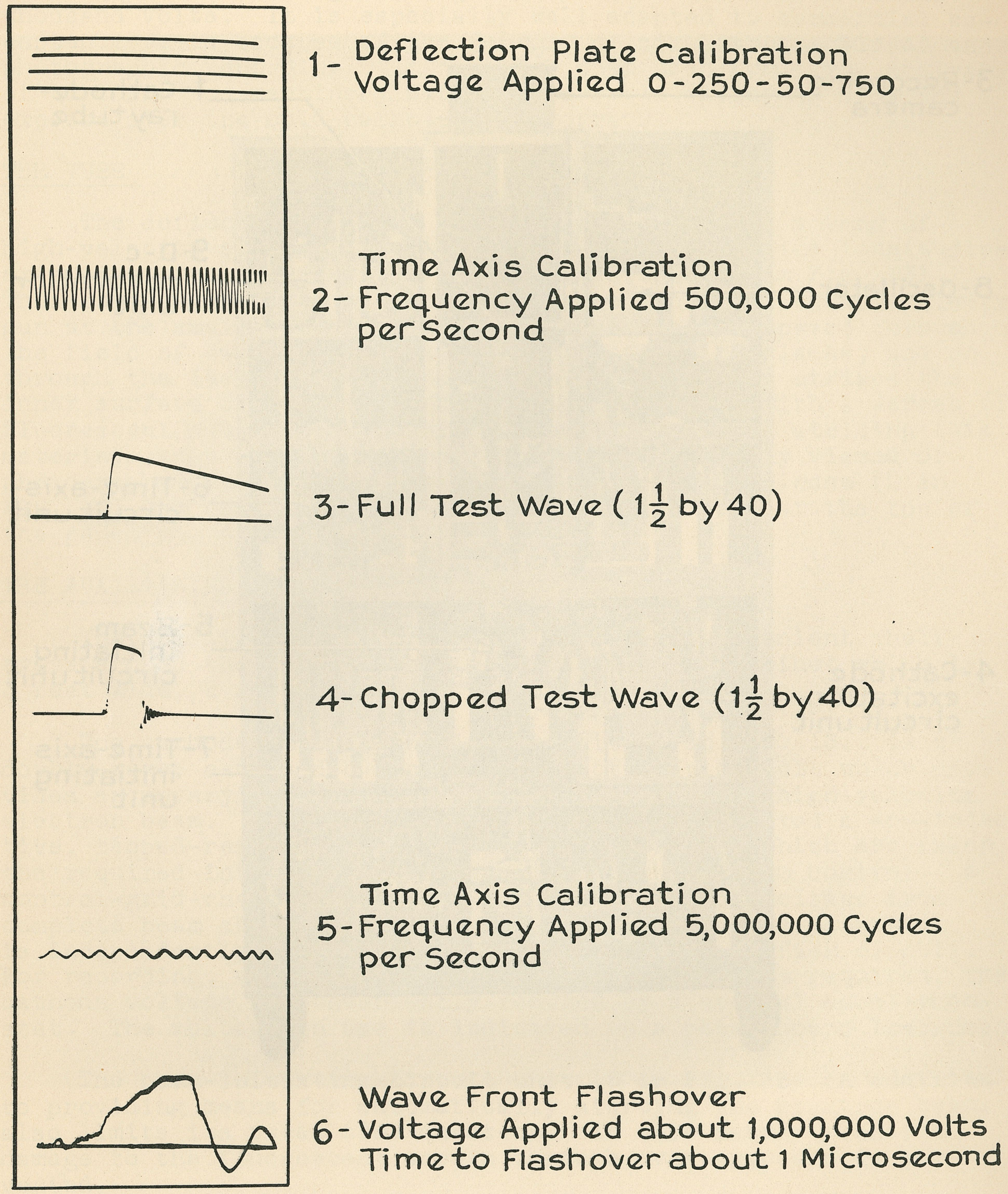


FIG. 14 HC15 CATHODE RAY OSCILLOGRAPH
SPECIMEN OSCILLOGRAMS

The time-axis-circuit unit (6 in Fig. 13) is connected to the set of deflection plates which are used to move the beam across the screen for the time-axis. This deflection is made uniform and of the required speed by adjustment of the circuit constants from the panelboard. This unit is automatically controlled, as to starting, through the time-axis-initiating unit (7 in Fig. 13).

For calibrating the time-axis, a variable frequency oscillator unit is provided (8 in Fig. 13). Through panelboard controls, this oscillator is connected to the time-axis-circuit deflection plates and adjusted to the required frequency.

A direct-voltage calibrating-circuit-unit (9 in Fig. 13) is provided for the deflection plates. This voltage is adjusted to the required value, and connected, through panelboard controls.

All these units are compactly built in the cabinet and permanently wired to the control panel. The equipment is so distributed and shielded that interference effects are eliminated. The rear covers are removable, giving easy access to all units.

The record size depends upon the camera used. Cameras may be supplied for 1 to 1, 2 to 1, or 5 to 1 reduction of the fluorescent screen image. For general purpose work, including impulse testing, the 5 to 1 reduction is recommended. With this camera high recording speed is possible and convenient small-sized films are used.

THE RECORDS

The HC-15 cathode-ray oscillograph lends itself to almost any kind of oscillograph record required, as shown in Fig. 14. From top to bottom, in record 1 a sample of deflection plate calibration on direct voltage is reproduced, 2 is a record of a typical time-axis calibration using 500,000 cycles. 3 reproduces a full test wave of 1 1/2 x 40 shape, while 4 shows this same wave on a faster time-axis and chopped by a rod gap flashover. 5 is a record of another time-axis calibration using 5,000,000 cycles. 6 is a reproduction of a wave-front flashover which occurred in 1.0 microsecond on a wave front of 1,000 kv per microsecond.

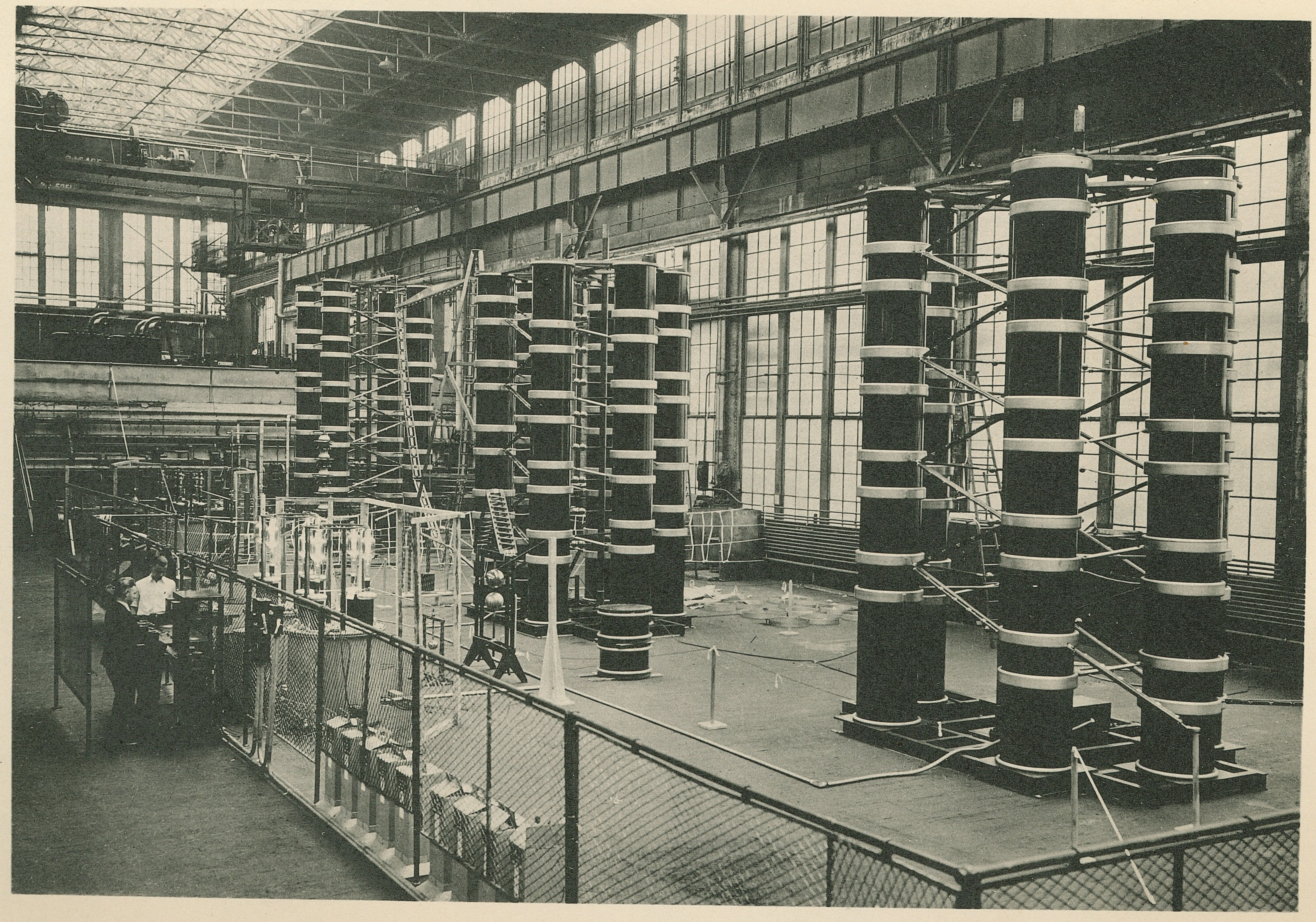


FIG. 15 G-E IMPULSE GENERATOR BEING ASSEMBLED AT THE FACTORY

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COPY OF QUOTATION

LOCKE INSULATOR CORPORATION
HIGH VOLTAGE LABORATORY EQUIPMENT
FILE 5101 - PROP. QPT-2198

Pittsfield, May 16, 1940

Mr. R. L. McCoy, Engineer
Locke Insulator Corporation
South Charles & Cromwell St.
Baltimore, Maryland

This quotation is in reply to your request of April 22, directed to Mr. J. A. Kestner of our Manufacturing General Department in Schenectady. Mr. Kestner made a visit to Pittsfield, discussing your request with our engineers, and has asked that we quote you directly.

This quotation does not cover Items 5 and 6 of your request. By copy of this quotation, together with a copy of your request, directed to Dr. J. J. Smith of the General Engineering Laboratory at Schenectady, we are asking that he furnish you with quotation on cathode-ray oscillograph equipment.

One of our engineers with whom we would like to discuss the load capacitor requested under Item 6 of your quotation, is at present out of town, and we have deferred quotation on this portion (Item 6) of your request until his return.

ITEM NO. 1:

Equipment for 3000-kv impulse generator to consist of the following:

(1) 200-kv neutral grounded d-c supply. Half wave rectification, complete to operate from a 220-volt, 25-cycle, single-phase supply, including:

(a) Two 100-kv 1/4-amp rectifier units with combined main and filament transformer tubes and auxiliaries.

(b) Current-limiting reactor.

Mr. R. L. McCoy
May 16, 1940

ITEM NO. 1: (Cont'd)

(c) IRS motor-operated regulator.
(d) Two solenoid-operated discharge switches.
(e) Benchboard type panel complete with controls, instruments, and auxiliaries.

Structural steel base for assembly and support of main impulse generator.

Supporting frame for shunt and series control resistors complete with hoists.

Resistance cards for control resistors non-inductive - flat wound.

Initiating unit for tripping impulse generator and coordinating oscillograph with generator.

Cable resistance voltage divider.

All of the above equipment will be new.

Main capacitor unit, parallel charging resistors, and discharge gap assembly to be taken from equipment now in use at Steinmetz Hall at the New York World's Fair.

APPROX NET PRICE, f.o.b. Pittsfield, for all of the above equipment $22,000

For an impulse generator rated 4000 kv rather than 3000 kv, the supporting frame for the shunt and series control resistors would have to be made larger, additional resistance cards for the control resistors, and additional capacitor units, parallel charging resistors, and discharge gap unit would be required.

Increase in price for this additional material will be approximately ....$ 4,000

Mr. R. L. McCoy May 16, 1940

You will note that the quotation covers a 200-kv half-wave charging rectifier. For the 3000-kv generator and using this rectifier, the charging time would be approximately 30 seconds. If a shorter charging time than this is required, it can be obtained with this same rectifier adjusted for slightly over-voltage on its excitation side, assuming that it is not necessary to go to the maximum rating of the generator. Our engineers consider that the charging unit as quoted will be entirely adequate and that the added cost of the full-wave rectifier would not be justified. The increase in price for the full-wave rectifier rated 1/2 ampere (instead of 1/4) would be approximately $1500.

It is the opinion of our engineers that the 3000-kv set having a capacitance of 0.011 microfarad (equivalent discharge energy 50 kilowatt seconds) will be more than ample for any requirements which you may have. It is believed that your testing will be largely on samples of relatively low capacitance and the voltage drop with the capacitance available in the generator should not be serious.

Because of the capacitor rating and general design of the newer type generators, the material which you list as available from the old generator will not be at all suitable and our engineers see but little opportunity of salvaging it for use with the new equipment.

We are enclosing copies of Bulletin GEP-167 giving general description of our impulse testing equipment. When you have decided on the rating of equipment preferred, we shall be glad to furnish firm prices.

The amount of any present or future sales or other similar tax applicable to the apparatus sold hereunder shall be added to the prices contained herein and paid by the purchaser in the same manner and with the same effect as if originally added thereto.

If you wish any further information, please advise.

RWB//E R. W. BARKER
JA Kestner-Sch'dy
JJ Smith -Sch'dy
HS Hubbard-Pittsfield POWER TRANSFORMER SECTION
Enc